

LISTING OF CLAIMS:

The present listing of claims replaces all previous versions and listings in the present application.

Please cancel claims 1-19 without prejudice or disclaimer.

1. -19. (Canceled)

20. (Currently amended) A method for manufacturing an optical device, comprising the steps of:

etching a semiconductor substrate with a predetermined mask so that a plurality of trenches is formed in the substrate and a plurality of semiconductor wall is formed between the trenches; and

thermally oxidizing the substrate so that the semiconductor wall is transformed into a semiconductor oxide wall and the trench is filled with semiconductor oxide,

wherein the semiconductor oxide wall and the semiconductor oxide in the trench provide an optical part, ~~and~~

wherein the optical part is integrally formed with the substrate, and passes a light therethrough, and

wherein the step of thermally oxidizing the substrate is performed under a condition that a bottom of the semiconductor wall is integrated with the substrate.

21. (Currently amended) The ~~device~~method according to claim 20,

wherein the semiconductor substrate is made of silicon, and the semiconductor wall is made of silicon, and

wherein the optical part is made of silicon oxide,

wherein the semiconductor oxide wall and the semiconductor oxide in the trench are adhered together in the step of thermally oxidizing the substrate.

22. (Original) The method according to claim 20,

wherein the trench has a width, and the semiconductor wall has another width, and

wherein the widths of both of the trench and the semiconductor wall are determined in such a manner that the trench is filled with the semiconductor oxide and at the same time the semiconductor wall is transformed into the semiconductor oxide wall in the step of thermally oxidizing the substrate.

23. (Currently amended) The method according to claim 22, for manufacturing an optical device, comprising the steps of:

etching a semiconductor substrate with a predetermined mask so that a plurality of trenches is formed in the substrate and a plurality of semiconductor wall is formed between the trenches; and

thermally oxidizing the substrate so that the semiconductor wall is transformed into a semiconductor oxide wall and the trench is filled with semiconductor oxide,

wherein the semiconductor oxide wall and the semiconductor oxide in the trench provide an optical part,

wherein the optical part is integrally formed with the substrate, and passes a light therethrough,

wherein the trench has a width, and the semiconductor wall has another width,
wherein the widths of both of the trench and the semiconductor wall are determined in
such a manner that the trench is filled with the semiconductor oxide and at the same time the
semiconductor wall is transformed into the semiconductor oxide wall in the step of thermally
oxidizing the substrate, and

wherein a ratio between the width of the trench and the width of the semiconductor wall
is 0.55:0.45.

24. (Currently amended) ~~The~~A ~~method according to claim 20,~~for manufacturing an optical
device, comprising the steps of:

etching a semiconductor substrate with a predetermined mask so that a plurality of
trenches is formed in the substrate and a plurality of semiconductor wall is formed between the
trenches; and

thermally oxidizing the substrate so that the semiconductor wall is transformed into a
semiconductor oxide wall and the trench is filled with semiconductor oxide,

wherein the semiconductor oxide wall and the semiconductor oxide in the trench provide
an optical part,

wherein the optical part is integrally formed with the substrate, and passes a light
therethrough,

wherein a plurality of trenches and semiconductor walls provide an optical-part-to-be-
formed region,

wherein the trench further includes an outside trench, and the semiconductor wall further
includes an outside semiconductor wall, and

wherein the optical-part-to-be-formed region is surrounded with the outside trench so that the outside semiconductor wall is disposed on an outmost periphery of the optical-part-to-be-formed region.

25. (Original) The method according to claim 24,

wherein the optical-part-to-be-formed region includes a plurality of trenches and semiconductor walls, each of which is parallel each other and disposed alternately so that the optical part becomes a plano-convex lens, a plano-concave lens, a biconvex lens, a biconcave lens, and a meniscus lens.

26. (Original) The method according to claim 24,

wherein the outside semiconductor wall has a width being equal to or smaller than that of the semiconductor wall disposed between the trenches.

27. (Original) The method according to claim 24,

wherein the outside trench has a sufficient width so that the outside trench has a clearance after the semiconductor oxide is formed on a sidewall of the outside trench in the step of thermally oxidizing the substrate.

28. (Original) The method according to claim 20,

wherein each trench is parallel to an optical axis of the optical part.

29. (Currently amended) The method according to claim 20,

wherein the step of etching the substrate ~~including~~includes the steps of:

etching the substrate ~~with~~ using a reactive ion etching method so that an initial trench is formed;

forming a passivation oxide film in an inner wall of the initial trench;

etching the passivation oxide film disposed on a bottom of the initial trench; and

etching the bottom of the initial trench with using the reactive ion etching method so that a final trench having a high aspect ratio is formed.

30. (Original) The method according to claim 20,

wherein the optical part includes at least one of a lens, a light guide or a slit so that the optical part is integrally formed with the substrate.

31. (Original) The method according to claim 20,

wherein the step of thermally oxidizing the substrate further includes the step of:

depositing a semiconductor oxide film in a clearance in the trench in a case where the trench has the clearance after the semiconductor oxide is formed on a sidewall of the trench in the step of thermally oxidizing the substrate.

32. (Currently amended) ~~The~~A method ~~according to claim 20, for manufacturing an optical device, further comprising the step~~steps of:

etching a semiconductor substrate with a predetermined mask so that a plurality of trenches is formed in the substrate and a plurality of semiconductor wall is formed between the trenches;

thermally oxidizing the substrate so that the semiconductor wall is transformed into a semiconductor oxide wall and the trench is filled with semiconductor oxide; and

forming an epitaxial layer on the substrate,
wherein the semiconductor oxide wall and the semiconductor oxide in the trench provide an optical part,
wherein the optical part is integrally formed with the substrate, and passes a light therethrough, and
wherein the epitaxial layer includes an impurity concentration distribution having a chevron shape in a film thickness direction perpendicular to the substrate.

33. (Original) The method according to claim 32,
wherein the optical part includes the epitaxial layer so that the optical part condenses a light in a vertical direction, which is perpendicular to the substrate.

34. (Currently amended) The method according to claim 20, further comprising the step of:
implanting an impurity on the substrate so that an impurity doped layer is formed,
wherein the impurity doped layer includes an impurity concentration distribution having a chevron shape in a film thickness direction perpendicular to the substrate.

35. (Original) The method according to claim 20, further comprising the step of:
annealing the substrate in a dopant atmosphere so that an impurity doped layer is formed,
wherein the impurity doped layer includes an impurity concentration distribution having a chevron shape in a film thickness direction.

36. (Currently amended) The method according to claim 27, further comprising the step
of:
forming an epitaxial layer on the substrate,
wherein the epitaxial layer includes an impurity concentration distribution having a
chevron shape in a film thickness direction, and
wherein the epitaxial layer includes germanium, phosphorous, tin or boron as an impurity.